

CLAIMS

What is claimed is:

[c1] 1. A method for a multi-protocol edge switch to process received data frames, the edge switch connected to at least two networks that each use distinct data link layer network protocols, the method comprising:

receiving multiple data frames transmitted from source nodes on a first of the networks that uses a first data link layer network protocol, each data frame comprising a header and a payload specified in a manner specific to the first data link layer network protocol, each header including an indication of a destination network address corresponding to a node on a second of the networks and each payload including a message specified using an application layer network protocol; and

for each of the multiple received data frames,

deconstructing the data frame to identify the indicated destination network address and the payload for the data frame, the deconstructing performed in a manner based on the first data link layer network protocol;

without deconstructing the data frame a second time, processing the deconstructed data frame by,

analyzing the identified payload in order to determine a type of the included message, the analyzing performed in a manner based on the application layer network protocol used to specify the included message;

analyzing the identified payload to verify an absence of disallowed content;

selecting one of multiple nodes of the second network to which the identified destination network address corresponds, the multiple nodes

each associated with the identified destination network address, the selecting performed so as to balance processing loads on the multiple nodes; and

constructing a distinct data frame for transmission to the selected one node, the distinct data frame comprising a header and the identified payload and specified in a manner specific to the data link layer network protocol used by the second network; and

transmitting the constructed distinct data frame to the selected one node on the second network,
so that each of the received data frames can be processed in multiple ways based on a single deconstruction of the data frame before transmitting the payload of the data frame to a destination node.

[c2] 2. The method of claim 1 wherein the processing of each of the deconstructed data frames includes performing in parallel the analyzing of the payload to determine the type of the included message, the analyzing of the identified payload to verify the absence of disallowed content, the selecting of the one node and the constructing of the distinct data frame.

[c3] 3. The method of claim 2 wherein the analyzing of the payload to determine the type of the included message, the analyzing of the identified payload to verify the absence of disallowed content, the selecting of the one node and the constructing of the distinct data frame are each performed on distinct processors of the multi-protocol edge switch.

[c4] 4. The method of claim 1 wherein the analyzing of the identified payload of each of the data frames to verify an absence of disallowed content is performed after the analyzing of that identified payload to determine a type of the included message, and wherein the analyzing of the identified payload to verify an absence of disallowed content is performed in a manner specific to the determined type of the included message of that identified payload.

[c5] 5. The method of claim 1 wherein the selecting of the one node for each of the data frames is performed after the analyzing of the identified payload of that data frame to determine a type of the included message, and wherein the one node that is selected for each of the data frames is based at least in part on a correspondence of that one node to the determined type of the included message of the identified payload for that data frame.

[c6] 6. The method of claim 1 wherein the transmitting of each of the distinct data frames constructed based on a received data frame is performed in a manner based at least in part on the determined type of the included message of the identified payload for that received data frame.

[c7] 7. The method of claim 1 including:
receiving an outgoing data frame that indicates a destination node on the first network, the data frame transmitted by a source node on one of the other networks that uses a second data link layer network protocol distinct from the first data link layer network protocol;
deconstructing the outgoing data frame to identify the indication of the destination node and to identify a payload for the data frame, the deconstructing performed in a manner specific to the second data link layer network protocol;
constructing a distinct data frame for transmission to the destination node, the distinct data frame specified in a manner specific to the first data link layer network protocol; and
transmitting the constructed distinct data frame to the destination node.

[c8] 8. The method of claim 1 wherein the data link layer network protocol used by one of the networks is an Ethernet protocol.

[c9] 9. The method of claim 1 wherein the data link layer network protocol used by one of the networks is a Fibre Channel protocol.

[c10] 10. The method of claim 1 wherein the data link layer network protocol used by one of the networks is an InfiniBand protocol.

[c11] 11. The method of claim 1 wherein the deconstructing of each of the data frames is performed by a network processor of the multi-protocol edge switch.

[c12] 12. The method of claim 1 wherein the deconstructing of each of the data frames further identifies a type of the identified payload, and wherein one or more of the analyzing of the payload to determine the type of the included message, the analyzing of the identified payload to verify the absence of disallowed content, the selecting of the one node and the constructing of the distinct data frame is performed in a manner based at least in part on the identified type of the identified payload.

[c13] 13. The method of claim 1 wherein the message included in at least some of the identified payloads is an HTTP message, and wherein the analyzing of each of those payloads to determine the type of the included message includes identifying a Uniform Resource Identifier specified in the message.

[c14] 14. The method of claim 1 wherein the analyzing of the identified payload of each of the received data frames includes extracting contents of the message included in that payload in a manner based on the application layer network protocol used to specify the message.

[c15] 15. The method of claim 1 wherein the transmitting of a constructed distinct data frame for a received data frame is not performed if the analyzing of

the identified payload of the received data frame to verify an absence of disallowed content fails to verify the absence.

[c16] 16. The method of claim 1 including, if the analyzing of the identified payload of a received data frame to verify an absence of disallowed content instead identifies a presence of disallowed content, modifying the identified payload that is included in the distinct data frame constructed for the received data frame so as to remove the disallowed content.

[c17] 17. The method of claim 1 wherein the transmitting of a constructed distinct data frame for a received data frame is not performed if the selecting of the one of the multiple nodes is unable to sufficiently balance the processing loads on the multiple nodes.

[c18] 18. The method of claim 1 including monitoring the processing loads on multiple of the nodes of at least one of the networks other than the first network, and wherein for at least some of the received frames the selecting of the one of the multiple nodes so as to balance the processing loads on the multiple nodes includes using the monitored processing loads.

[c19] 19. The method of claim 1 wherein for each of the received data frames, the constructing of the distinct data frame for transmission to the selected one node includes adding to the header of the distinct data frame an indication of a second destination network address corresponding to the selected one node that is distinct from the destination network address identified for that received data frame.

[c20] 20. The method of claim 1 including, for each of the received data frames, determining a transmittal virtual path identifier that is assigned to a path to the selected one node through the second network to which that node belongs,

and wherein the transmitting of the constructed distinct data frame to the selected one node on the second network uses the determined transmittal virtual path identifier so that the data frame is routed through the second network along the path.

[c21] 21. The method of claim 20 wherein, for each of the received data frames, the determined transmittal virtual path identifier is added to the header of the distinct data frame in place of a destination network address for the selected one node.

[c22] 22. The method of claim 20 wherein the determining of the transmittal virtual path identifier that is assigned to the path to the selected one node for a received data frame includes registering with a network manager for the second network to which the selected one node belongs and receiving in response the transmittal virtual path identifier.

[c23] 23. The method of claim 1 including, for each of the received data frames, determining one or more Quality Of Service parameters, and wherein the transmitting of each of the constructed distinct data frames is performed in accordance with the Quality Of Service parameters determined for that data frame.

[c24] 24. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data of interest; and

processing the deconstructed data by,

analyzing at least some of the identified portions in order to classify a type of those portions of the received data;

analyzing contents included in at least some of the identified portions in order to determine whether a specified type of content is present; and

determining the destination for the received data in a manner so as to load balance multiple possible destinations.

[c25] 25. The method of claim 24 wherein the first protocol is a data link layer network protocol.

[c26] 26. The method of claim 24 wherein the first protocol is a network layer network protocol.

[c27] 27. The method of claim 24 wherein the first protocol is a transport layer network protocol.

[c28] 28. The method of claim 24 wherein the first protocol is an application layer network protocol.

[c29] 29. The method of claim 24 wherein the first protocol is a bus protocol.

[c30] 30. The method of claim 24 wherein the first protocol is Fibre Channel.

[c31] 31. The method of claim 24 wherein the first protocol is InfiniBand.

[c32] 32. The method of claim 24 wherein the received data is a data frame or a data packet, and wherein the identified portions of the received data include a header portion of the received data.

[c33] 33. The method of claim 24 wherein the received data is a data frame or a data packet, and wherein the identified portions of the received data include a payload portion of the received data.

[c34] 34. The method of claim 24 wherein the identified portions of the received data include entries in a header portion of the received data.

[c35] 35. The method of claim 24 wherein the identified portions of the received data include portions of a payload of the received data.

[c36] 36. The method of claim 24 wherein the deconstructing of the received data is performed only a single time.

[c37] 37. The method of claim 24 including communicating the received data to the destination.

[c38] 38. The method of claim 24 including determining a virtual identifier that corresponds to a path through the network to the destination and that will be used to route the received data through the network to the destination.

[c39] 39. The method of claim 24 wherein the classifying of the type of the identified portions of the received data includes classifying those identified portions in a manner based on an application layer protocol used to format the data of those identified portions.

[c40] 40. The method of claim 24 wherein the analyzing of the contents included in the identified portions includes determining whether at least some of the identified portions include prohibited content.

[c41] 41. The method of claim 40 including blocking transmittal of the received data when it is determined that one or more of the identified portions include prohibited content.

[c42] 42. The method of claim 40 including, when it is determined that one or more of the identified portions include prohibited content, removing the prohibited content from the received data.

[c43] 43. The method of claim 24 wherein the analyzing of the contents included in the identified portions includes determining whether at least some of the identified portions do not include required content.

[c44] 44. The method of claim 24 including providing firewall functionality based on the analyzing of the contents included in the identified portions.

[c45] 45. The method of claim 24 wherein the processing of the deconstructed data includes formatting the received data in accordance with a distinct second protocol.

[c46] 46. The method of claim 24 wherein the analyzing of the contents included in the identified portions is performed in a manner based at least in part on the classified type of those identified portions.

[c47] 47. The method of claim 24 wherein the analyzing of the identified portions in order to classify the type of those portions is performed in a manner based at least in part on the determination of whether the specified type of content is present.

[c48] 48. The method of claim 24 wherein the determining of the destination is additionally performed in a manner based at least in part on the classified types of the analyzed identified portions.

[c49] 49. The method of claim 24 wherein the determining of the destination is additionally performed in a manner based at least in part on the determination of whether the specified type of content is present.

[c50] 50. The method of claim 24 wherein each of the analyzing of the identified portions, the analyzing of the included contents and the determining of the destination is performed in parallel.

[c51] 51. The method of claim 24 wherein each of the analyzing of the identified portions, the analyzing of the included contents and the determining of the destination is performed on a distinct processor.

[c52] 52. The method of claim 24 wherein the method is performed by a multi-protocol edge switch connected to at least two networks that each use distinct protocols.

[c53] 53. A computer-readable medium whose contents cause a computing device to process received data communications by performing a method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in order to identify portions of the received data; and

processing the deconstructed data by,

detecting whether a specified type of content is present in at least some of the identified portions; and

when the specified type of content is not detected to be present, load balancing multiple possible destinations for the received data in order to determine a destination to which the received data will be communicated.

[c54] 54. The computer-readable medium of claim 53 wherein the computer-readable medium is a memory of a computer system.

[c55] 55. The computer-readable medium of claim 53 wherein the computer-readable medium is a data transmission medium transmitting a generated data signal containing the contents.

[c56] 56. The computer-readable medium of claim 53 wherein the processing of the deconstructed data further includes classifying a type of at least some of the identified portions of the received data.

[c57] 57. The computer-readable medium of claim 53 wherein the processing of the deconstructed data further includes formatting the received data in accordance with a distinct second protocol and indicating to communicate to the determined destination the data formatted in accordance with the second protocol.

[c58] 58. The computer-readable medium of claim 53 wherein the deconstructing of the received data is performed only a single time.

[c59] 59. A computing device for processing received data communications, comprising:

a first component capable of receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

a deconstruction component capable of deconstructing the received data in order to identify portions of the received data; and

one or more processing components capable of processing the deconstructed data by detecting whether a specified type of content is present in at least some of the identified portions and by determining a destination to which the received data will be communicated if the specified type of content is not detected to be present, the determining of the destination by load balancing multiple possible destinations for the received data.

[c60] 60. The computing device of claim 59 wherein the one or more processing components are further capable of processing the deconstructed data by classifying a type of at least some of the identified portions of the received data.

[c61] 61. The computing device of claim 59 wherein the computing device is a multi-protocol node on the network, and wherein the one or more processing components are further capable of processing the deconstructed data by formatting the received data in accordance with a distinct second protocol and by indicating to communicate the data formatted in accordance with the second protocol to the determined destination.

[c62] 62. The computing device of claim 59 wherein the first component and the deconstruction component are executing in memory of the computing device.

[c63] 63. The computing device of claim 59 wherein the processing components execute in parallel.

[c64] 64. The computing device of claim 59 wherein the processing components each execute on a distinct processor of the computing device.

[c65] 65. A computer system for processing received data communications, comprising:

means for receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

means for deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

means for processing the deconstructed data by,
classifying a type of content included in at least some of the identified portions of the received data;

detecting whether a specified type of content is present in at least some of the included content; and

when the specified type of content is not detected to be present, load balancing multiple possible destinations for the received data in order to determine a destination to which the received data will be communicated.

[c66] 66. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in order to identify portions of the received data each having contents; and

processing the deconstructed data by,
classifying a type of the contents of at least some of the identified portions of the received data;

analyzing at least some of the contents in order to determine whether a disallowed type of content is present, the analyzing based at least in part on the classified types of the contents; and

when the disallowed type of content is determined to be present, preventing the communicating of the received data to the destination.

[c67] 67. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

processing the deconstructed data by,

classifying a type of at least some of the identified portions; and

constructing a new group of data that is formatted in accordance with a distinct second protocol to be communicated to the destination, the constructing based at least in part on the classifying.

[c68] 68. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

processing the deconstructed data by,

classifying a type of at least some of the identified portions; and

formatting the received data in accordance with a distinct second protocol, the data formatted with the second protocol to be transmitted to the destination in a manner based at least in part on the classifying.

[c69] 69. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

processing the deconstructed data by,
analyzing contents of at least some of the identified portions in order to detect whether a specified type of content is present;
determining whether to allow the received data to be communicated to the destination based on whether the specified type of content is detected as being present; and
when it is determined to allow the received data to be communicated, formatting the received data in accordance with a distinct second protocol that corresponds to the destination and indicating to communicate to the destination the data formatted in accordance with the second protocol.

- [c70] 70. A computer-implemented method for processing received data communications, the method comprising:
- receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;
 - deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and
 - processing the deconstructed data by,
 - analyzing contents included in at least some of the identified portions in order to determine whether a disallowed type of content is present; and
 - when it is determined that the disallowed type of content is not present,
 - determining a destination for the received data in a manner so as to load balance multiple possible destinations; and
 - formatting the received data in accordance with a distinct second protocol for communicating to the determined destination.

[c71] 71. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

processing the deconstructed data by,

classifying a type of at least some of the identified portions;

load balancing multiple possible destinations for the received data in order to determine a destination to which the received data will be communicated; and

formatting the received data using a distinct second protocol that corresponds to the determined destination.

[c72] 72. A computer-implemented method for processing received data communications, the method comprising:

receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;

deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data; and

processing the deconstructed data by,

classifying a type of at least some of the identified portions;

determining whether a specified type of content is present in at least some of the identified portions; and

when the specified type of content is not detected to be present, formatting the received data in accordance with a distinct second protocol.

[c73] 73. A computer-implemented method for processing received data communications, the method comprising:

- receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;
- deconstructing the received data in order to identify portions of the received data; and
- processing the deconstructed data by,
 - classifying a type of content included in at least some of the identified portions;
 - analyzing the included contents in order to provide firewall functionality;
 - determining a destination for the received data in such a manner as to load balance multiple possible destinations; and
 - formatting the received data in accordance with a distinct second protocol.

[c74] 74. A computer-implemented method for processing received data communications, the method comprising:

- receiving data to be communicated through a network to a destination, the received data formatted in accordance with a first protocol;
- deconstructing the received data in a manner based on the first protocol in order to identify portions of the received data;
- processing the deconstructed data by,
 - classifying a type of content included at least some of the identified portions;
 - analyzing the content included in at least some of the identified portions;
 - determining a destination for the received data in such a manner as to load balance multiple possible destinations; and

constructing a new group of data that is formatted using a distinct second protocol; and

transmitting the constructed new group of data to the determined destination.

[c75] 75. The computer-readable medium of claim 53 wherein the contents are instructions that when executed cause the computing device to perform the method.

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